"Litter marks" around oil palm tree base indicating infiltration area of stemflow-induced water

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Abstract

The "litter marks" which has the dark color and shape like a circle was found around the oil palm tree base. These litter marks seem to be caused by the infiltration excess overland flow due to higher intensity of stemflow than the infiltration capacity of surface soil. An experiment was conducted to determine relationships between the diameter at the tree base and the radius of litter mark or infiltration area mark from the center of the stem. Result shows that the litter marks around oil palm tree base can be a useful indicator to estimate the infiltration area of stemflow-induced water.

Key words: *litter mark, infiltration area, oil palm tree, stemflow*.

1.0 INTRODUCTION

Canopies of forested and agricultural ecosystems, including oil palm trees, can significantly alter rainfall patterns into stemflow and throughfall areas. However, the effect of stemflow on the groundwater recharge is relatively large (Taniguchi et al., 1996). Previous studies have shown that stemflow can be a major source of tree-induced infiltration and subsequent flow in and below the soil root zone, including recharge (Pressland, 1976, Tanaka et al., 1996, Aboal et al., 1999, Gómez et al., 2002, Liang et al., 2007, Sansoulet et al., 2008, Liang et al., 2011).

The infiltration area of the stemflow-induced water, A_i was needed to determine groundwater recharge amount as a unit of water column, R_s (R_s = amount of stemflow/A_i). However, it is difficult to evaluate A_i. Tanaka et al. (1991) evaluated A_i based on the data of "infiltration area mark" which have the shape like a circle, whereas Iida et al., (2005) evaluated it based on the

data of litter mark. Formation of litter marks was from the movement of the litter due to higher intensity of stemflow than the infiltration capacity of surface soil (Iida et al., 2005). Herwitz (1986) also evaluated A_i from the observed data of stemflow intensity and infiltration capacity of surface soil in a tropical rain forest (A_i = intensity of stemflow/infiltration capacity).

Pressland (1976) reported that all stemflow infiltrates into the soil within the area of 50 cm around large trees with circumferences larger than 40 cm and within the area of 30 cm around the smaller trees with circumferences less than 20 cm. Iida et al. (2005) observed that the litter marks under Farmosa sweet gum and evergreen oak seem to be caused by the infiltration excess overland flow due to higher intensity of stemflow than the infiltration capacity of surface soil.

Oil palm is the major agricultural crop in Malaysia. From the previous studies, the investigation about litter mark or infiltration area mark under oil palm trees especially in tropical climate country is still lack. The purpose of this study is to evaluate the availability of litter marks around oil palm tree base in estimating infiltration area of stemflow-induced water, A_i.

2.0 METHOD

The measurement litter marks of oil palm trees (*Elaeis Guineensis*) were carried out at oil palm plantation, Kangkar, Johor Darul Takzim, Malaysia. The plantation was established around 19 years ago. Figure 1 show the litter mark found around the tree base of oil palm tree respectively. From the figure, it is obviously shows that the shape of the litter marks almost circle. The radius of litter mark,*y* from the center of oil palm tree stem and diameter of the tree base,*x* were determined by tape measures. There are 30 oil palm trees were measured in this experiment.

Figure 1: Litter mark around the tree base of oil palm tree (*Elaeis Guineensis*).

3.0 RESULTS AND DISCUSSION

3.1 Possible formation process of litter marks under oil palm trees

The dark color and shape like a circle was found around the oil palm tree base (see Figure 1). This finding was corresponded with the shape of infiltration area marks of stemflow reported by Tanaka et al. (1991) for the Keyaki stand, Japanese zelkova and Iida et al. (2005) for Farmosa sweet gum and evergreen oak.

The litter marks under oil palm tree was occurred naturally. During rainfall event, the intercepted rainfall will funnels down along the stem and indirectly bring down all the litters around the fronds to the soil surface. Furthermore, the physical characteristic of oil palm stem which are having rough appearance because it was wrapped in fronds will make the stemflow take a long time to reach the soil surface. However, the amount of rainwater infiltrate into the soil by stemflow was higher compared to throughfall. For example, Liang et al. (2007) observed

that cumulative stemflow per unit infiltration area along the downslope side of a tree trunk was nearly 20 times the cumulative open-area rainfall rate. Sansoulet et al. (2008) similarly found that stemflow caused the infiltration rates around a banana stem to be up to six times higher than in the throughfall areas. Several other studies observed differences between stemflow and throughfall rates, including for olive trees (Gómez et al., 2002), banana plants (Cattan et al., 2009), tall stewartia (Liang et al., 2009), and ponderosa pine (Guan et al., 2010).

3.2 Relationship between diameter at tree base and radius of litter mark

Figure 2 shows the relationships between the diameter at the tree base and the radius of litter mark from the center of the stem. It shows that the radius of litter mark,*y* was increased with increasing the diameter tree base, *x*. Rutter (1963) reported that stemflow increase linearly with the increasing square of stem diameter. The relationship between the diameter at the tree base and the radius of litter mark from the center of the stem showed a logarithmic curve as follows:

$$y = 1.0171\ln(x) + 1.985 \quad (1)$$

$$R^2 = 0.715$$

The regression,R^2 obtained in this study was similar as Tanaka et al. (1991) and Iida et al. (2005) obtained even though type of vegetation was different. In this study, the range of diameter tree base of oil palm trees is 0.58 m to 0.97 m and the range radius of litter mark is 1.5 m to 2.0 m. Equation (1) indicates that no stemflow inputs occur close to the base small diameter trees of approximately 0.15 m. Hence, the litter mark around oil palm tree can be a useful indicator of A_i.

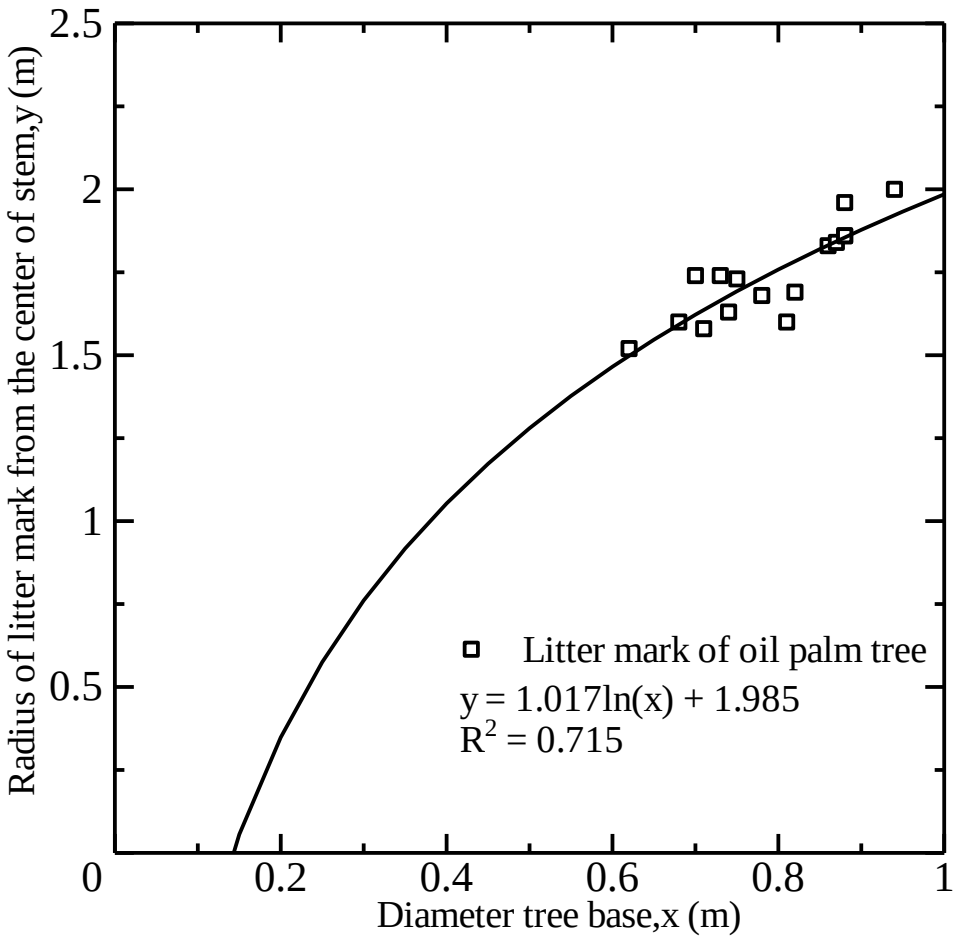

Figure 2: Relationships between the diameter at the tree base and the radius of litter mark or infiltration area mark from the center of the stem.

4.0 CONCLUSION

The litter mark around oil palm tree base can be used to estimate infiltration area of stemflow-induced water. Equation that obtained from this study can be used at the mature oil palm plantation especially in Malaysia and others tropical climate country with same vegetation. Litter marks result from the stemflow-induced water and the extent of the litter mark depends on the intensity of rainfall and the magnitude of infiltration capacity.

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